



# Obesity and the Brain

Implications and Potential Solutions  
for Children, Middle-Aged Adults,  
and Older Adults

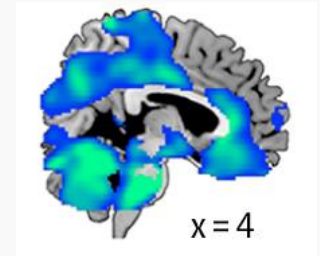
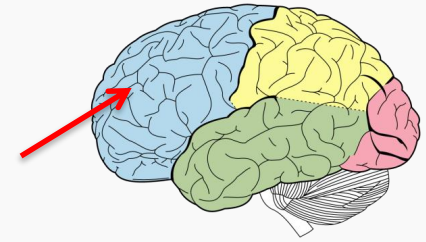
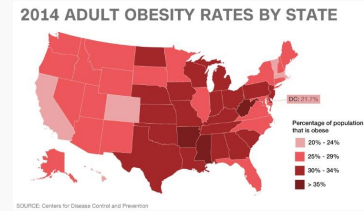
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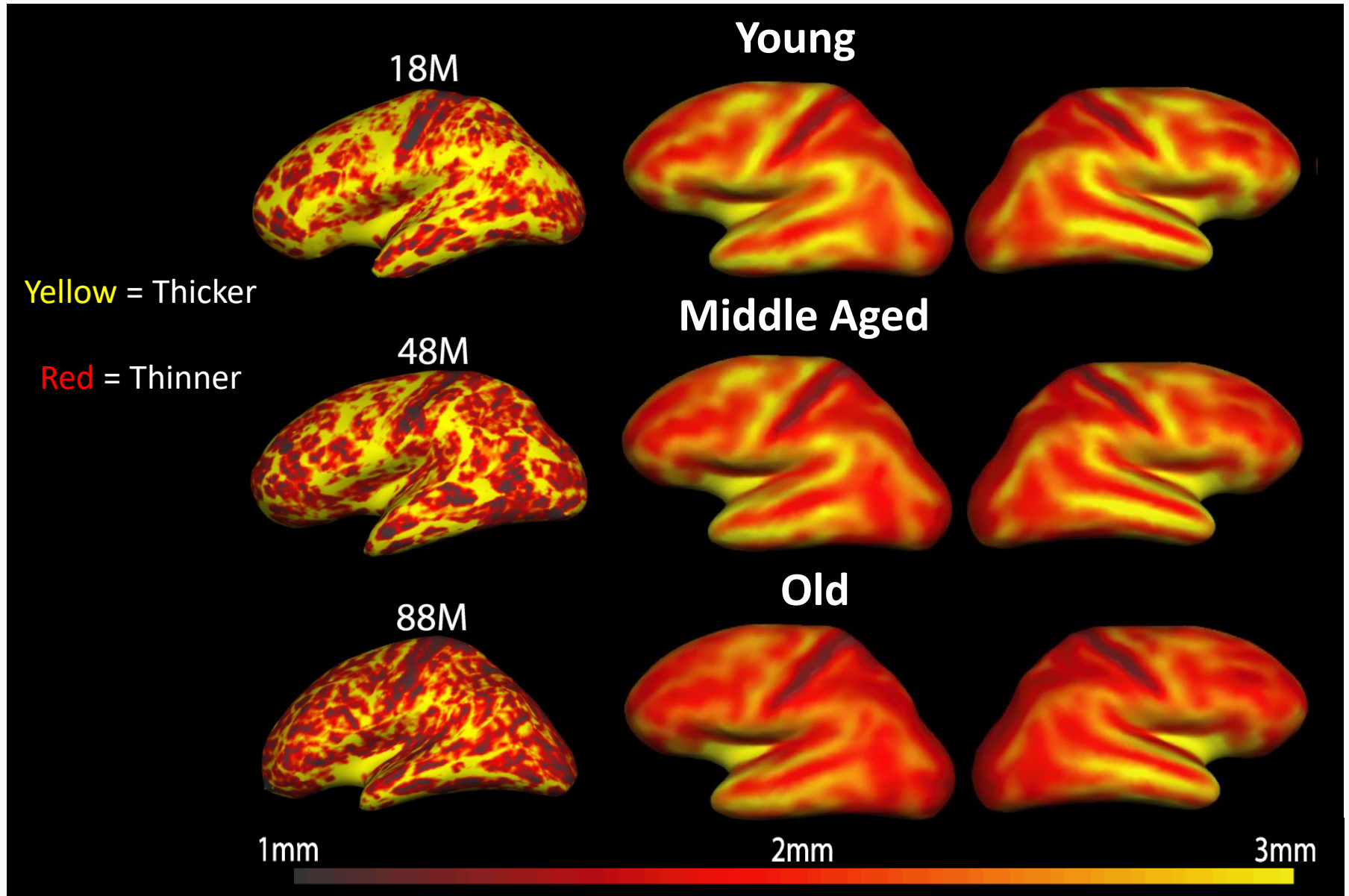
Courtesy Appointments in Psychology (ISU), Biomedical Sciences (ISU),  
and Neurology (U. Iowa)

# Outline and Take Homes First (!)

- Iowa is 13<sup>th</sup> in US and tied for 3<sup>rd</sup> in Midwest for adult obesity rates. Obesity is not about blame or shame. The obesity epidemic is very complicated.
- Obesity is consistently related to frontal lobe atrophy in kids to aged adults, which can impact “higher order” thinking.
- Insulin resistance, stemming from obesity, has bad effects on brain health in middle-aged people, “normal” aged people, and aged people across the Alzheimer’s disease spectrum.
- To combat obesity and maintain lean muscle: incentivize fruit consumption, less processed meat consumption, and more moderate activity. Changes can improve brain right away.
- Simple things like walking 2 hours/week may help combat Alzheimer’s disease.

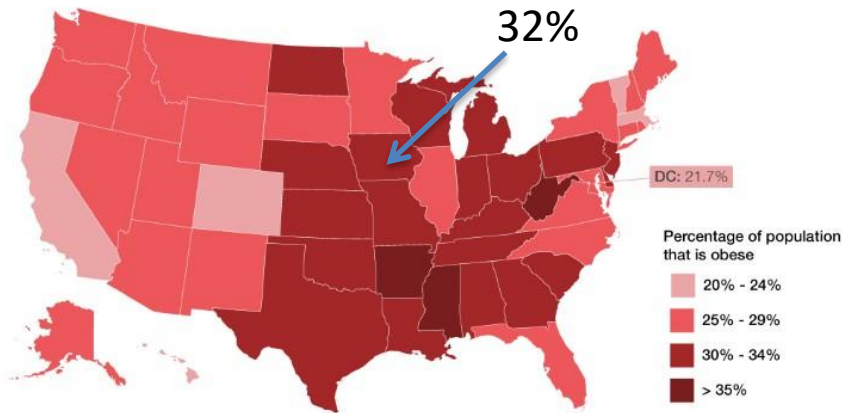


# Brain Shrinks/Atrophies Over the Human Lifespan



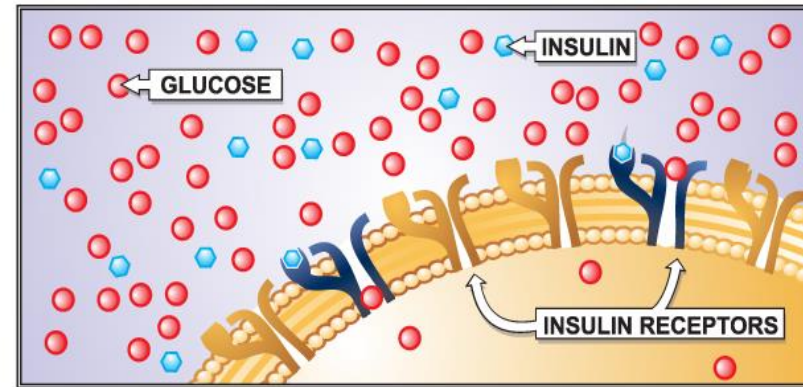
# Obesity, Metabolic Problems, and Brain Health

2014 ADULT OBESITY RATES BY STATE



SOURCE: Centers for Disease Control and Prevention

INSULIN RESISTANT CELL



# Obesity is NOT a Character Flaw

- The idea that gluttony and sloth cause obesity, while accepted by virtually everyone, is based on faulty premises and questionable science.
- Meta analyses (i.e., studies summarizing studies) show that excess calorie consumption and lack of activity have small to moderate effects in predicting obesity.
  - We had similar television, video game, and eating habits (somewhat) back in the 1990's, when obesity rates were MUCH lower<sup>1</sup>. Increased computer use has only increased sedentary time per day by 45 minutes on average.
- McAllister et al. (2010) put forward several novel explanations for the obesity epidemic:
  - Changes in gut microflora with certain diets
  - Novel viruses that can cause fat accumulation
  - Environmental modification of genes that regulate fat storage
  - Sleep deprivation
  - Hormonal imbalances

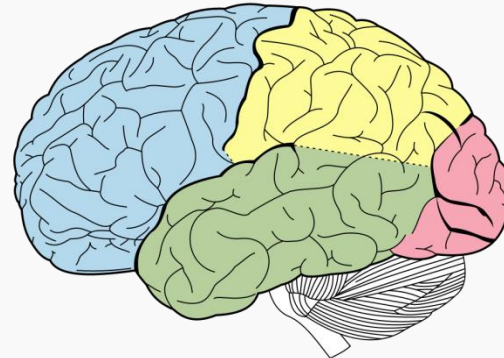
<sup>1</sup>See “Educating the Student Body” at National Academies Press, Chapter 2



# Obesity, Health Risks, and Brain Health Risks

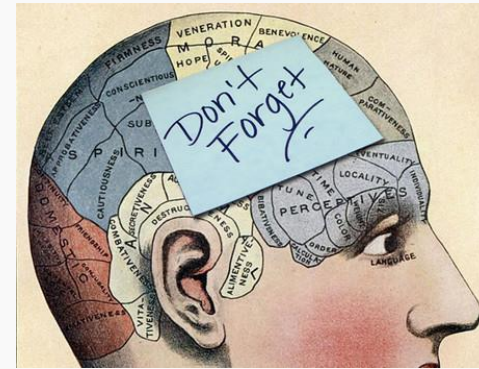
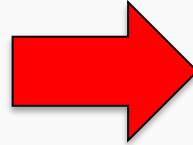
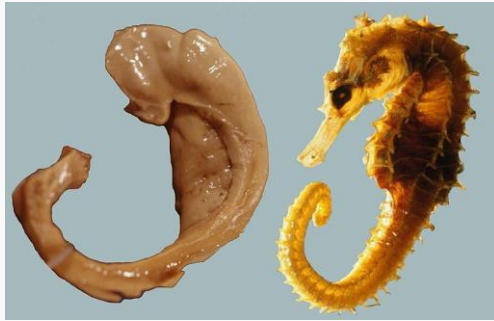


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# Hippocampus and Obesity



## Children to Young Adults

- 2 of 9 of studies show more atrophy associated with obesity

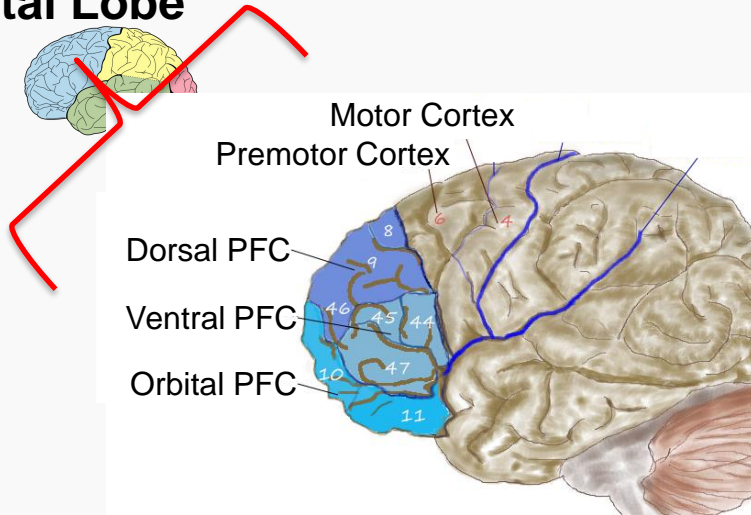


## Middle-Aged to Aged Adults

- 9 of 19 of studies show more atrophy associated with obesity

# Prefrontal Cortex and Obesity

## Frontal Lobe



## Higher Order Thinking Skills



## Children to Young Adults

- 6 of 9 of studies show more atrophy associated with obesity

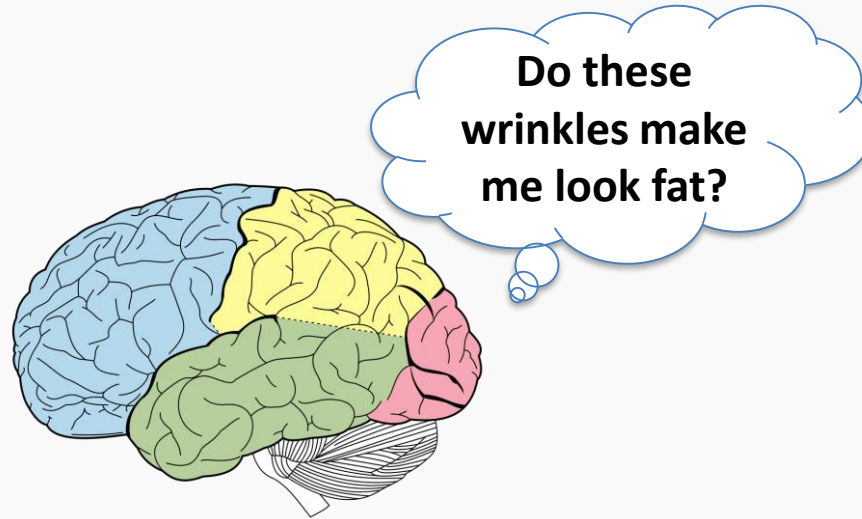


## Middle-Aged to Aged Adults

- 12 of 15 of studies show more atrophy associated with obesity

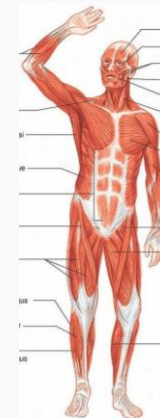
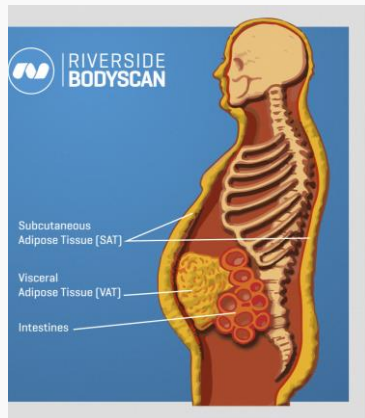
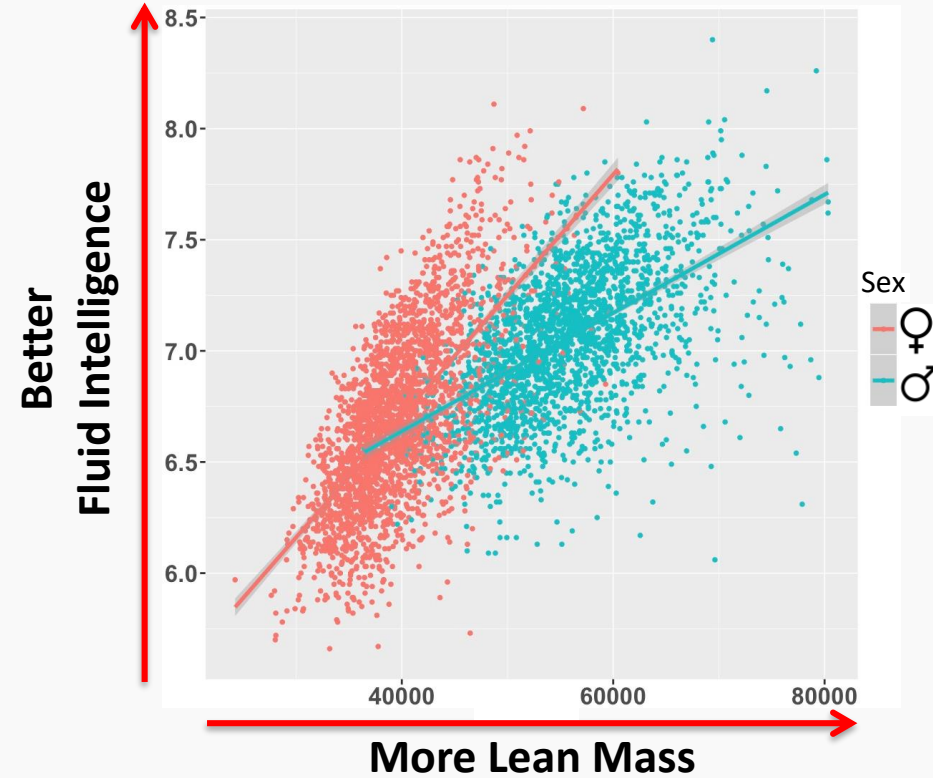
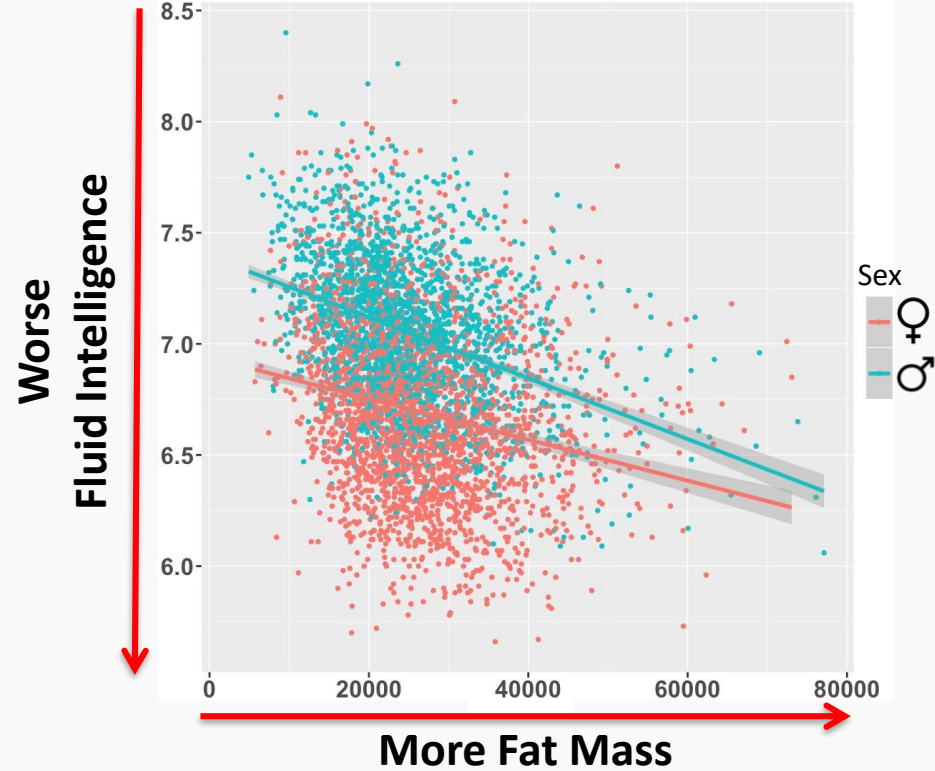


# Conclusions



- **Hippocampus, memory, and aging**
  - Obesity in literature shows inconsistent associations
  - Literature on obesity and memory is very mixed
- **Prefrontal cortex, “higher order” thinking, and aging**
  - Obesity in literature shows consistent associations
  - Literature on obesity and “higher order” thinking is very clear
- **What exactly does the term atrophy mean here?**
  - Atrophy not due to neural cell death, but fewer cell-to-cell connections
  - Weight loss appears to reverse this brain atrophy and problems with thinking

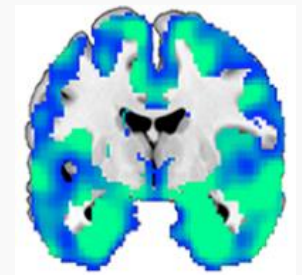
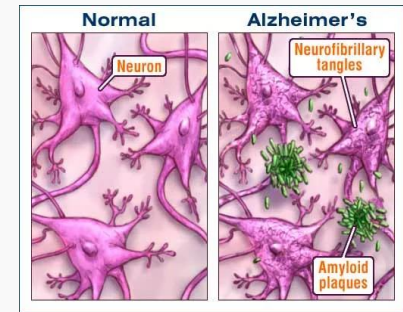
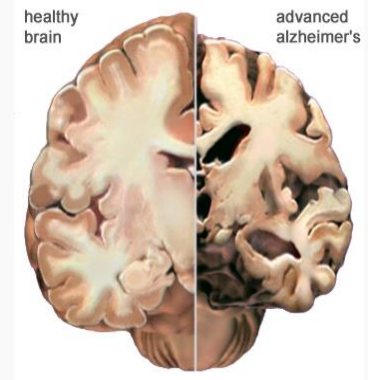
# Body Mass and Flexible Thinking



# **Alzheimer's Disease and Obesity Related Problems**

# Alzheimer's disease (AD) and the Brain

- In AD, unlike normal aging, the brain atrophies due to massive cell death
- During which brain pathology sets in...
  - Amyloid plaques and tau tangles
- And the brain also uses less glucose to power cells
  - Insulin resistance may play a role
- This is a problem, because by 2050
  - Up to 15.6 million Americans will be affected
  - Up to 1.1 trillion/year in Medicare costs





# AD Effects on Thinking and Emotion

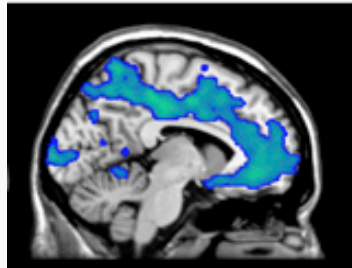
- More frequent or severe episodes of forgetfulness
  - Navigating familiar roads
  - Recent conversations
  - Acquaintances, friends, and eventually family
- Depression, anxiety, and especially irritability
- Increased mental inflexibility
  - Difficulty adapting to new situations

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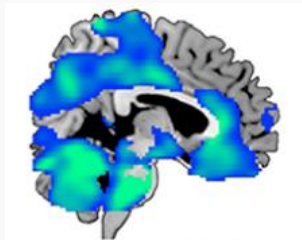


# Our “Greatest Hits” Collection of Recent Findings

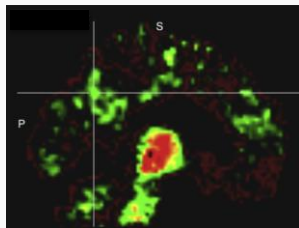
## Middle-Aged, At Risk



Brain Atrophy

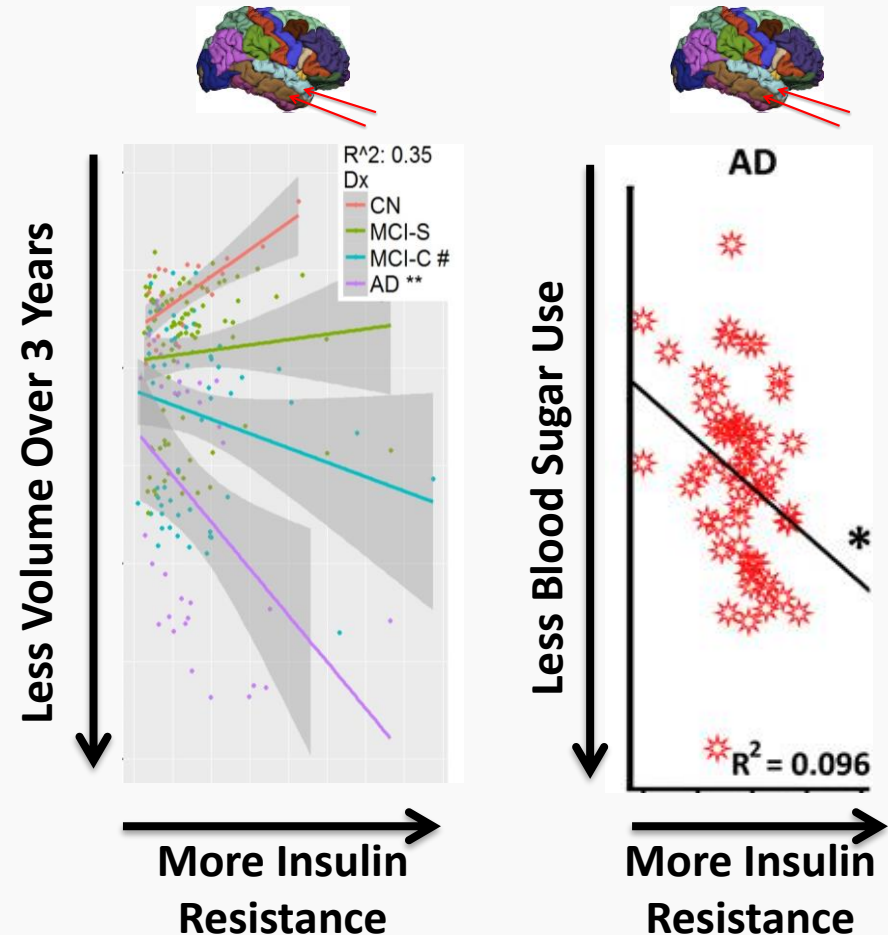


Blood Sugar  
Use



Amyloid Plaques

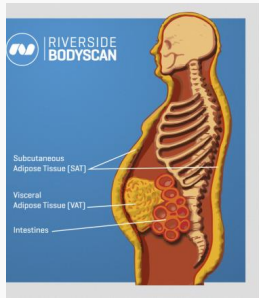
## Aged, Across AD Spectrum



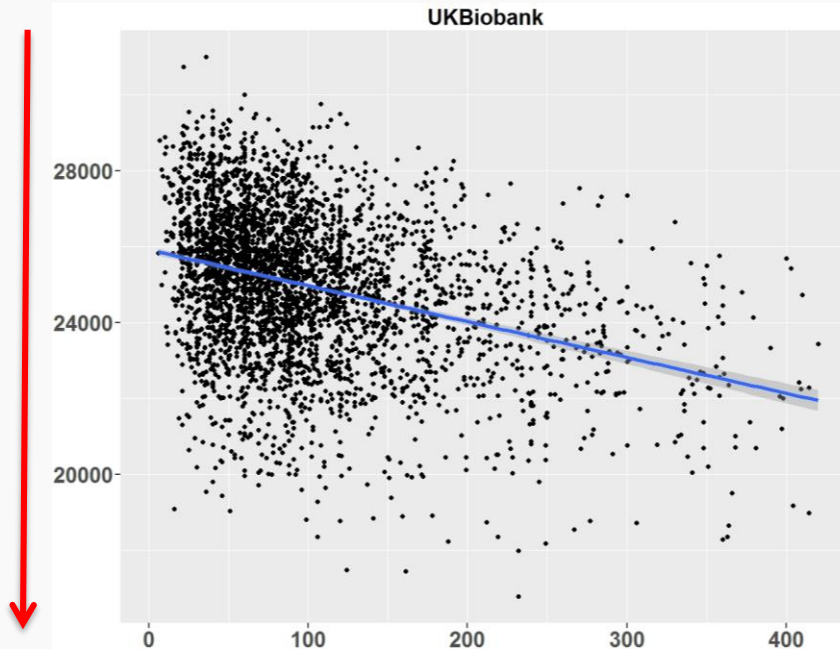
Willette et al., 2013, Diabetes Care  
Willette et al., 2015 Alzheimer's & Dementia  
Willette et al., 2015 Diabetes  
Willette et al., 2016 JAMA Neurology  
Klinedinst et al., Alzheimer's and Dementia, in review

**What can help improve brain health in  
Iowa?**

# Body Mass and Moderate Physical Activity

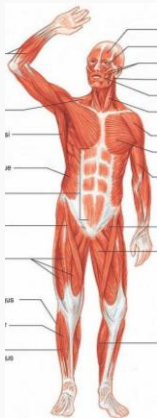


Less  
Fat Mass



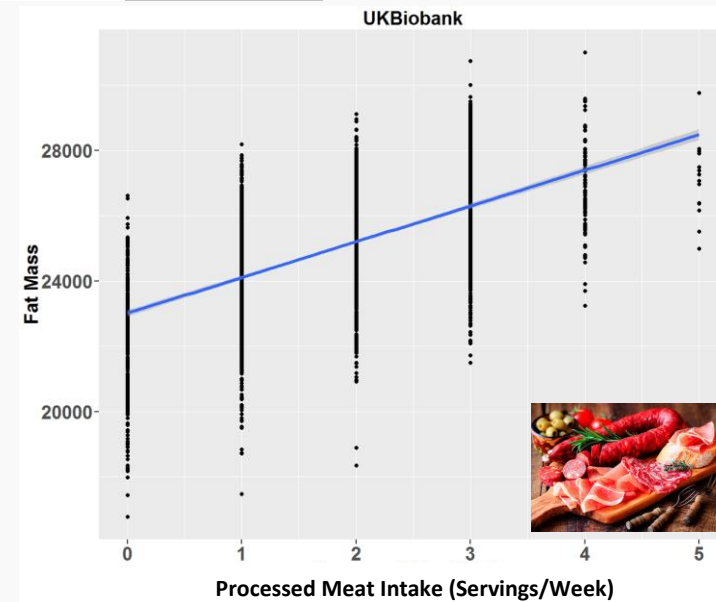
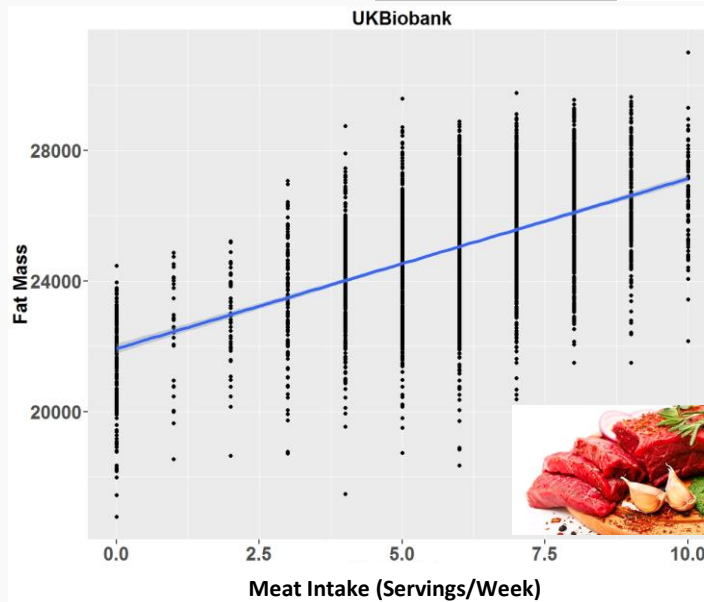
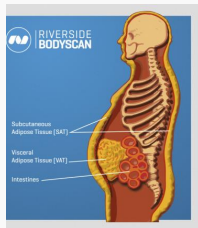
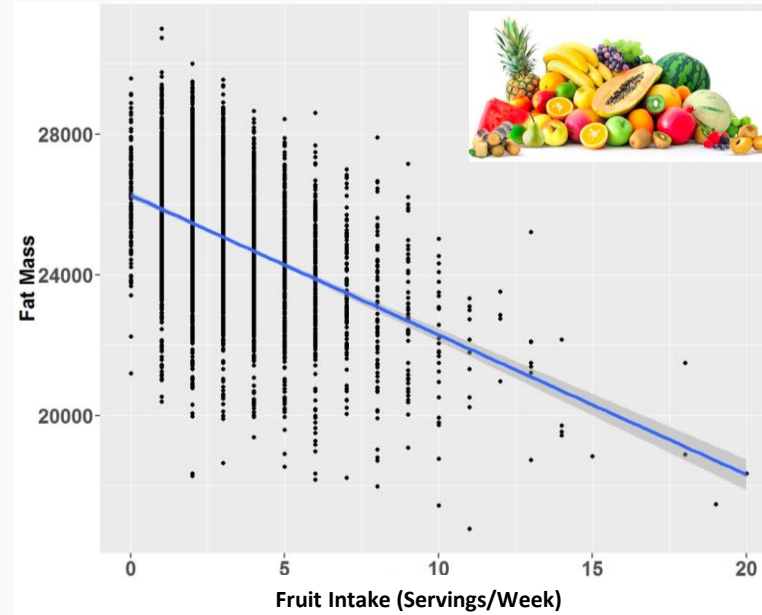
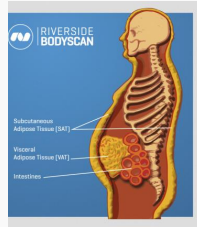
More Moderate Physical Activity  
(Minutes/Week)

Moderate  
activity still  
**CRITICAL** for  
maintaining  
lean muscle  
mass



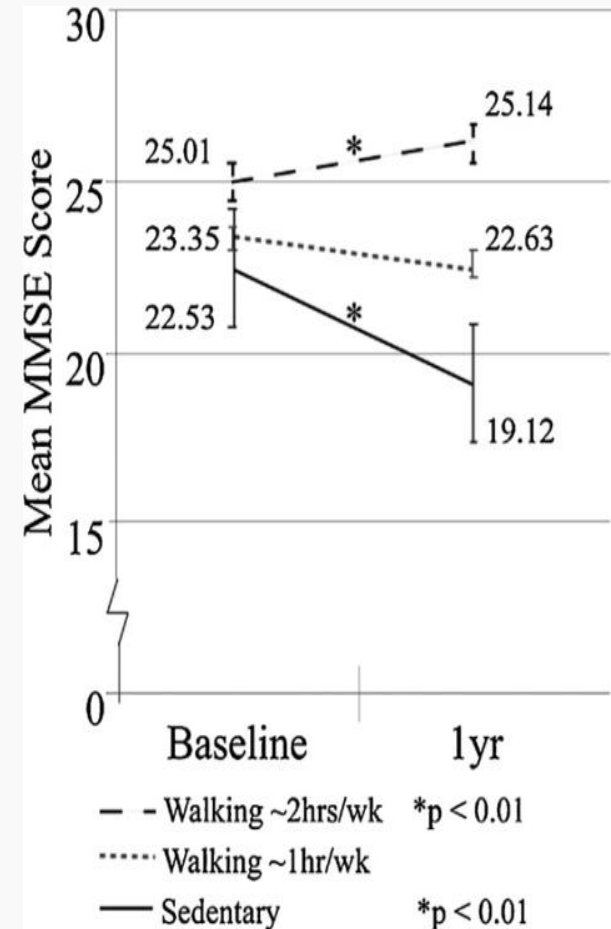


# Body Mass and Intake of Fruits vs. Meats



# Potential Therapy for AD

## Walking



- Walking for 1 year in people with AD

# Acknowledgements

## Lab

Brandon Klinedinst  
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Scott Le  
Army of undergrads



## Funding



Additional Slides  
for Reference



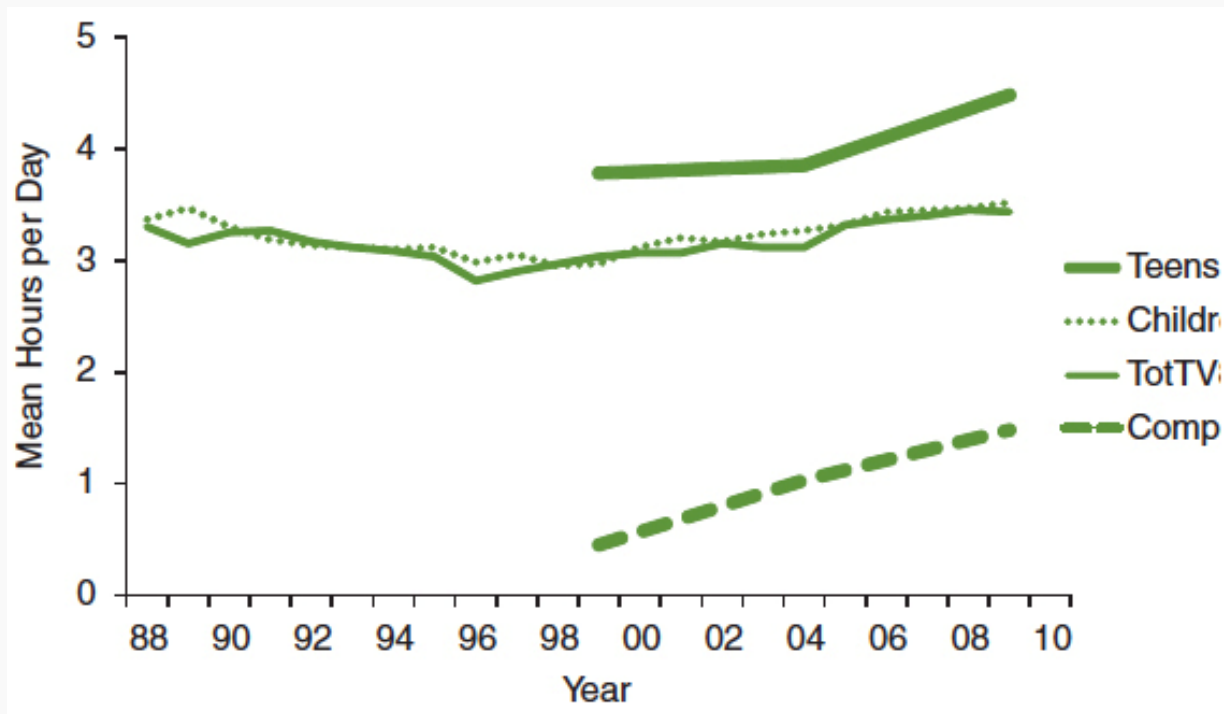


FIGURE 2-12Hours per day spent watching television by age group, 1998–2009, and hours per day spent watching television and using computers for youth aged 8-18

NOTES: TotTV = total television content, which includes watching not only standard television programs but also prerecorded shows, DVDs, and television content on other platforms (e.g., Internet, cell phone, iPod); Comp = does not include time spent using a computer for schoolwork.

SOURCES: Rideout et al., 2010; TVB, 2012.